

## **UNDERSTANDING INFORMATION SYSTEMS IN ORGANIZATIONS: FROM ANTHONY'S FRAMEWORK TO THE *ORGANIZATIONAL MIND***

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**Abstract** *Recent developments in information technology and in information systems led to a change in the discourse about information systems in organizations: with increasing frequency, knowledge is referred to as the object that is manipulated by information systems or as the result of using them. Sometimes this change brings up some inconsistency to explanations of information systems use. This inconsistency can be viewed as a symptom of a paradigm crisis that demands a new form of viewing the information systems' phenomena. Adding a cognitive dimension to a systemic view of organizations contributes to avoiding the inconsistency and constitutes an insight to the use of information systems in organizations. The organizational mind conceptual framework explores concepts and conceptual schemas borrowed from human cognitive studies and neurosciences and opens new perspectives for looking to information systems and information technology in organizations and in society.*

**Keywords** *information systems, information technology, organizations, organizational mind*

### **Introduction**

The use of computers in organizations has been growing since the appearance of the first applications of this information processing technology to support organizational work in the 1950s. This growth is specially related to the diversity of organizational activities where computer-based information technology are being used. Often referred to as *computer-based information systems* or just *information systems* (IS) the applications of computer-based information technology are currently unavoidable in modern organizations. Regardless of their dimension, the business domain they operate in, and even if they do not aim for profit, IS are present to support organizational activities.

Early IS were quite easy to describe and explain: there were several organizational activities that involved carrying out some combination of arithmetic operations. Although the calculations that had to be done were normally quite simple, the large amounts of information to be processed made this procedure repetitive and error prone when carried out by humans, even

when humans were helped by calculating machines (mechanical or electro-mechanical). This situation constituted the entry point of computers in organizations: machines capable of processing large amounts of information without committing errors and becoming tired. First applied to situations where the results produced by the computers were used in the business value chain (data processing), they were later applied to other situations like producing management reports (information for management). Quite satisfactory descriptions of early computer applications and IS could be achieved using an *input-process-output* type explanation: what information is used as input; what processing is carried out; what information is produced as result. To specify an IS corresponded to describe the input, the output and the computer program that could automate the processing.

With the subsequent developments of information technology and its use and the consequent widespread presence of IS in organizations, it became more difficult to explain what IS do and what roles they play in those organizations. IS evolved from computer applications built to automatize the processing of some well defined information and to produce some well identified result to more complex artifacts with several possible uses. The complexity of such artifacts justified the use of the term *system* to name them. Information systems (IS) became a very popular designation. Moreover, when attempting to explain their part in organizations, it became necessary to include mentions to the context where the IS are used. As IS aim at supporting managers, conceptual frameworks that address *managerial activities* become popular to characterize IS and to explain their use in organizations. Later, by the mid 1990s, the dissemination of local area networks put an emphasis on *communication* processes. More recently IT developments, such as data mining and other IS that aim to promote *knowledge* dissemination in organizations, demand new and more powerful conceptual frameworks that support robust explanation of the roles played by IS in organizations and might anticipate probable future developments of IT.

Starting on the framework for organizational activities used by Anthony in 1965 [1], this article goes through several conceptual frameworks that have been used to describe IS in organizations and presents a brief introduction to a novel perspective of organizations that has the potential to constitute the basis for a comprehensive and coherent explanation of the role of IS in organizations.

### **Conceptual frameworks used to provide context to explanations of IS usage in organizations**

Since the early 1970s, several attempts have been made to categorize IS and to produce taxonomies of IS. Perhaps the first one was made by Gorry and Scott Morton [2]. They used a two dimensions framework to classify IS: (i) managerial level supported by the IS - according to Anthony's framework for managerial activities [1]; (ii) type of problem addressed/decision to be made - whether structured, semi-structured or non-structured.

### *Managerial activities*

Gorry and Scott Morton's classification became quite popular and was largely cited in the years to come, either in textbooks (e.g., [3], [4], [5]) or in other IS classification attempts (e.g., [6], [7], [8], [9, 10]).

As a consequence Anthony's framework for managerial activities became a very popular conceptual framework to support explanations of IS use. Dated from mid 1960's Anthony's three levels of managerial activities framework can be associated with the bureaucratic model of organizations that resulted from the industrial era. It might be misleading in the modern situation of flexible organizations acting in a global market with more educated employees that demand autonomy and empowerment. So, alternative and more sophisticated models of managerial activities were also used to illustrate IS usage in modern organizations. For instance, Carvalho [11] uses the Viable System Model (VSM) proposed by Beer (e.g., [12], [13, 14]). VSM accounts for two important aspects: it differentiates among five managerial functions that are considered necessary to guarantee autonomy (coordination, control, audit, intelligence, and policy making) and suggests a recursive structure that is essential to assure organizations' viability. Besides accommodating explanations similar to those achieved with Anthony's framework, the VSM framework also provides the basis to explain the necessity/utility of several levels of information provision provided nowadays through the use of data warehousing and OLAP technology [11].

### *Decision-making*

When used to support managerial activities, IS are somewhat related to decision making. Therefore, decisions and the decision making process are also a popular dimension in IS taxonomies. Besides Gorry and Scott Morton other authors also included decision making as a dimension in their classifications: Alter [15] and [16]; Grimshaw [17]; Teng and Ramamurthy [18]; Mentzas [19]; Pearson and Shim [20]; Lewis [21]; Morais [9, 10].

### *Communication*

With the advent of local area networks, another aspect become important – communication. Computers started to be used to support activities that involve communication between several people (e.g., groupware systems). Therefore several features related to the communication process were, in some way, included in taxonomies, such as: Teng and Ramamurthy [18]; Mentzas [19]; Alter [16].

### *Business functions, processes and domains*

Some IS classifications also focus on organizational activities although they don't address the Anthony's distinction of managerial activities types. It is quite common to classify IS according to the functional area they are used in. Xu e Kay [22] focus specially in the production area. Morais [9, 10] uses the process classification proposed the APQC ([www.APQC.org](http://www.APQC.org)) as one dimension of her taxonomy. Among the reminder dimensions, business domains (e.g., industry,

health care, education) are used to help to classify IS that support operational activities.

### **New perspectives on IS: dealing with knowledge**

In recent years it became quite popular to mention that IS deal with knowledge. This isn't particularly new. The first references to computer based systems that deal with knowledge are quite old and have their roots in artificial intelligence applications. Expert systems and their integrating knowledge bases are as old as 1985 [23]. It is also easy to accept that the models bases that integrate decision support systems deal with some form of knowledge as well. And decision support systems are even older than expert systems.

However, the increasing frequency of such mentions to knowledge suggest a change in discourse and might also indicate that we are living a paradigm shift in the way we perceive IS in organizations.

In our view, knowledge manipulation by IS really became an issue. This can be explained as resulting from a combination of several factors that allowed that the focus of computer use in organizations shifted from just dealing with information to interfering with human capabilities for action. Such factors include the following:

- Widespread use of IS in organizations such as data mining, workflow management systems, e-groups, several communication services available upon the internet that go well beyond the long-standing processing of information according to previously known rules or algorithms;
- New organizational and social practices enabled by those computer based systems (IT in general) such as: knowledge discovery in databases; workflow management; just-in-time; supply chain management; electronic commerce; customer relationship management; communities of practice; knowledge management;
- Dissemination of personal computers and mobile computing and communication devices and their interconnection through the internet.

### *Cognition systems*

Acknowledging that IS deal with knowledge opens up a whole new perspective for looking at IS in organizations: organizations as *cognition systems*, i.e., systems that exhibit cognition features similar to those that can be found in humans.

In fact, organizations can be viewed as collective enterprises where purposeful action is carried out. This action can correspond either to operational action (action to produce the results it is supposed to produce according to its purpose) or to managerial action (action to guarantee the organization's survival and well being). Action demands acting capabilities that, for the cases of intellectual/mental/cognitive action, can be presented as composed by knowledge and intelligence. Knowledge corresponds to images of the internal and external

state of affairs, models of the dynamics of the world and other mental images created based on the others forms of knowledge. Intelligence might include capacities such as to perceive, to memorize, to reason, to imagine, to solve problems, to plan a desired future.

#### *Types of knowledge*

It is possible to use those concepts to look at what IS do in organizations. In what concerns knowledge, we can use a classification of “cognitions” proposed by Bunge [24] to distinguish among different types of knowledge: perceptual, conceptual and behavioral. *Perceptual knowledge* can be associated to whatever can be known through perceptual mechanisms. *Conceptual knowledge* can be associated to the results of reasoning upon perceptual knowledge and conceptual knowledge. *Behavioral knowledge* corresponds to knowing how to do something.

#### *Manipulation of knowledge representations by IS*

Representations of any of those types of knowledge are dealt with by IS. For instance, what we normally call *data processing systems* deal with representations of perceptual knowledge (e.g., records of what exists in a warehouse, what is being sold, the customers’ names and addresses, etc.). They use forms of deductive reasoning to produce some result that is necessary in an organization’s value chain. *Management information systems* aren’t very different. They also apply forms of deductive reasoning upon representations of perceptual knowledge. However, the aim of these IS is to produce some form of conceptual knowledge such as management indicators. The decision models of *decision support systems* correspond to conceptual knowledge. The role of *decision support systems* is to support deductive reasoning using those models to produce alternative scenarios for a course of action. These scenarios are a form of conceptual knowledge as well as they result from reasoning. *Workflow management systems* incorporate descriptions of what to do – representations of behavioral knowledge – to coordinate action in organizations. *Data mining systems* carry out inductive reasoning upon perceptual knowledge to produce conceptual knowledge such as customers’ patterns of behavior.

The role played by any type of IS can be re-interpreted according to the cognition system conceptual framework outlined above. In certain cases computers can be viewed as amplifiers of human cognitive capabilities, enhancing human capacity for perceiving, memorizing, reasoning, communicating. In other cases IS became autonomous elements of the cognition mechanisms of an organization (including elements that support communication and interaction among the other elements). They interact with other IS and with humans (directly or through their cognitive amplifiers) to constitute a collective *organizational mind*.

### **Organizational mind**

The *organizational mind* is a conceptual framework under development that attempts to explore concepts from the human mind to develop a new perspective on organizations. The term organizational mind is not new. It has already been used by several authors within various studies of organizations and society (e.g., [25], [26],[27], [28], [29], [30]). However, known approaches to the organizational mind address sociological, economic, or technological views separately and don't provide a comprehensive perspective of organizations as a collective mind. On the other hand, recent developments in the neurosciences (e.g., [31], [32], [33], [34]) brought some new insights that worth to be taken into consideration.

The *organizational mind* comprises processes and phenomena corresponding to those found in the human mind. Obviously these processes and phenomena should be sought at an organizational macro level and not at the level of the individuals and machines that are the acting elements of the organization. It is our expectation that the organizational mind constitutes an interesting and useful framework to assist the study of how collective experience is understood and memorized, highlighting the events and objects that organizations choose to pay attention to. It assists also in understanding the language elements upon which the organizational experience is constructed and what processes enable organizations to reason about that experience. By constructing representations about itself and its environment, an organization, as a collective self, creates a sense of meaning about the world and its action in that same world. The organizational mind framework can be used to improve an organization's capabilities for survival and also to guide its members' search for their collective well-being.

Using the organizational mind framework, researchers and managers are able to evaluate an organization's mental capabilities such as:

- intelligence – how its members use the available knowledge to plan and implement solutions to problems and environmental challenges, ensuring the organization's survival and well-being;
- learning ability – how their members collectively accommodate new experience by changing the way they perceive, think and behave;
- creativity – the organizations' capability to produce new ideas and new things to ensure a dynamic adaptation to the internal and environmental challenges and opportunities.

The organizational mind metaphor leads to the search of organizational behavior that supports the view that an organization acts as a coherent whole and is the cause for the emergence of a sense of a collective self that enables the organization to:

- control its reactions to environmental stimuli and to hold a sense a collective self interacting with external entities;

- monitor what is happening in its interior and exterior;
- envisage its future and develop courses of action to construct the envisaged future;
- evaluate the effectiveness of its processes and structure;
- appraise its internal, financial, and market well-being;
- develop a sense of responsibility towards the environment and society.

As in humans, these capabilities demand that an organization be capable of forming and using representations of itself and of the relevant external entities with which it interacts (self-representations), and other representations resulting from these (meta-representations). Such representations address:

- what is “perceived”, moment-by-moment, as happening in its internal and external environments;
- the organization’s envisaged future;
- the organization’s past experience;
- the organization’s structure, causal, and process models of its internal workings;
- structure, causal and process models of the organization’s social and economic environment;
- presumed images held by relevant stakeholders about the organization.

The organizational mind conceptual framework constitutes a new perspective on the use of IS in organizations. It offers new grounds for explaining what IS do in organizations. It might also contribute to new ways of accounting for the evolution verified in the developments of information technology and its applications in organizations. And, hopefully, it constitutes a firm basis for anticipating new forms of information technology applications capable of contributing to organizations’ survival and well being.

### **Conclusion**

The organizational mind conceptual framework sketched above is currently being developed within a research program that aims at producing a set of methods and tools for organizational intervention, with special emphasis on interventions related to the adoption and use of information technology in organizations.

It is possible to argue, this new conceptual framework constitutes a rupture with the perspectives on the use of IS in organizations used for the last 30 years or so. We believe that adding this cognitive system dimension to organizations constitutes an insight into what has been the human evolution in that time span. Surprisingly, or perhaps not, it contributes to our understanding of the roots of this era we live in and that is often called *information society*: like the industrial revolution was caused by the appearance of amplifiers of the human physical and motor capabilities, the emerging information society is fostered by amplifiers of the human cognitive capabilities.

## References

1. Anthony, R.N., *Planning and Control Systems: A Framework for Analysis*. 1965: Division of Research, Graduate School of Business Administration, Harvard University.
2. Gorry, G.A. and M.S. Scott-Morton, *A Framework for Management Information Systems*. Sloan Management Review, 1971. **13**(1): p. 55-70.
3. Laudon, K.C. and J.P. Laudon, *Management Information systems: Organization and Technology*. 4th ed. 1996: Prentice-Hall.
4. Lucas, H., *Information Technology for Management*. 6th ed. 1997: McGraw-Hill.
5. McLeod-Jr., R., *Management Information Systems: A Study of Computer-Based Information Systems*. 5th ed. 1993: Macmillan.
6. Kirs, P.J., et al., *An Experimental Validation of the Gorry and Scott Morton Framework*. MIS Quarterly, 1989. **13**(2): p. 183-197.
7. Doke, E.R. and T. Barrier, *An Assessment of Information Systems Taxonomies: Time to Be Re-Evaluated?* Journal of Information Technology, 1994. **9**: p. 149-157.
8. Adam, F., C. Murphy, and M. Fahy. *Cumulative Research in Decision Support System: A Practical Example*. in *3rd European Conference on Information Systems*. 1995.
9. Morais, P. and J.Á. Carvalho. *TAXIS – A Conceptual model to support the early stages of the ISD process*. in *ISD2001 - The Tenth International Conference Information Systems Development: New Perspectives on Information Systems Development: Theory, Methods, and Practice*. 2001. Royal Holloway, University of London, United Kingdom: Kluwer Academic/Plenum Publishers.
10. Morais, P. and J.Á. Carvalho. *Using a Taxonomy of Computer-Based Information Systems to Improve the Requirements Engineering Process*. in *BIT'99 – Business Information Technology Management: Generative Futures*. 1999. Manchester, Reino Unido.
11. Carvalho, J.A., *Using the Viable System Model to Describe the Role of Computer-Based Systems in Organisations*, in Callaos, Nagib, Linda Holmes and Rodolfo Osers (Eds.), *Proceedings of the SCI'98 - World Multiconference on Systems, Cybernetics and Informatics, July 12 - 16, Orlando USA, Volume 4*. 1998. p. 497-502.
12. Beer, S., *The Viable System Model: its Provenance, Development, Methodology and Pathology*. Journal of the Operational Research Society, 1984. **35**: p. 7-26.
13. Espejo, R. and R. Harnden, eds. *The Viable System Model: Interpretations and Applications of Stafford Beer's VSM*. 1989, John Wiley & Sons.
14. Espejo, R., et al., *Organizational Transformation and Learning: A Cybernetic Approach to Management*. 1996: John Wiley & Sons.
15. Alter, S., *A Taxonomy of Decision Support Systems*. Sloan Management Review, 1977. **19**(Fall): p. 39-56.
16. Alter, S., *Information Systems: A Management Perspective*. 3rd ed. 1999: Addison-Wesley.



17. Grimshaw, D.J., *Towards a Taxonomy of Information Systems: Or Does Anyone Need a Taxi?* Journal of Information Technology, 1992. 7: p. 30-36.
18. Teng, J.T.C. and K. Ramamurthy, *Group Decision Support Systems: Clarifying the Concept and Establishing A Functional Taxonomy*. INFOR, 1993. 31(3): p. 166-185.
19. Mentzas, G., *A Functional Taxonomy of Computer-Based Information Systems*. Inter. Journal of Information Management, 1994. 14(6): p. 397-410.
20. Pearson, J.M. and J.P. Shim, *An Empirical Investigation into Decision Support Systems Capabilities: A Proposed Taxonomy*. Information & Management, 1994. 27(1): p. 45-57.
21. Lewis, P., *Information Systems Development: Systems Thinking in the Field of Information Systems*. 1994, London: Pitman Publishing.
22. Xu, X.-Z. and G.R. Kaye, *Beyond Automation and Control: Manufacturing Information Systems from a Strategic Perspective*. International Journal of Information Management, 1997. 17(6).
23. Ein-Dor, P. and E. Segev, *A Classification of Information Systems: Analysis and Interpretation*. Information Systems Research, 1993. 4(2): p. 166-204.
24. Bunge, M., *Treatise on Basic Philosophy, Volume 4, Ontology II: A World of Systems*. Vol. Treatise on Basic Philosophy, Volume 4, Ontology II.: 1979: D. Reidel Publishing Company.
25. Mitroff, I., *Stakeholders of the Organizational Mind*. 1983, Jossey-Bass.
26. Schwenk, C.R., *Strategic Decision Making*. Journal of Management, 1995. 21(3): p. 471-493.
27. Weick, K.E. and K.H. Roberts, *Collective Mind in Organizations: Heedful Interrelating on Fight Decks*. Administrative Science Quarterly, 1993. 38(3): p. 357-381.
28. Levinthal, D.A. and C. Rerup, *Crossing an Apparent Chasm: Bridging Mindful and Less Mindful Perspectives on Organizational Learning*. Organizational Science, 2004.
29. Pawlowsky, P., *Management Science and Organizational Learning*, in *Handbook of Organisational Learning and Knowledge*, M. dierkes, et al., Editors. 2001, Oxford University Press.
30. Hoogerwerf, E.C. and A.-M. Poorthuis, *The Network Multilogue: A Chaos Approach to Organizational Design*. Journal of Organizational Change Management, 2002. 15(4): p. 382-390.
31. Damásio, A., *The Feeling of What Happens: Body and Emotion in the Making of Consciousness*. 1999, New York: Hartcourt Brace.
32. Damásio, A., *Looking for Spinoza: Joy, Sorrow, and the Feeling Brain*. 2003, london: William Heinemann.
33. Greenfield, S., *The Private Life of the Brain: Emotions, Counsciousness, and the Secret of the Self*. 2000, New york: John Wiley & Sons.
34. Churchland, P.S., *Self-representation in Nervous Systems*. Science, 2002. 296: p. 308-310.